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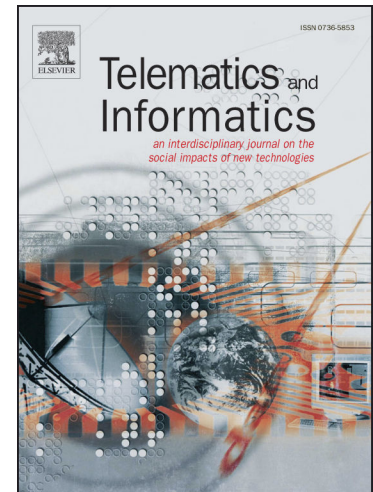
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Virtual Reality Adoption during the COVID-19 Pandemic: A Uses and Gratifications Perspective

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has impacted all aspects of people's lives, including how we work, play, learn, exercise, and socialize. Virtual reality (VR) technology has the potential to mitigate many of the challenges brought about by the pandemic,

which has spurred increased adoption. However, relatively low adoption overall and limited software still restrict the power of VR to address COVID-19 difficulties effectively. This study examines how the perceived impacts of COVID-19 might lead to different VR uses and gratifications and device ownership / variability. Furthermore, we investigate the importance of social interactivity within VR for increasing adoption intentions.

We surveyed 298 Amazon Mechanical Turk users during the Fall of 2020. Results indicate that the pandemic's perceived impacts influenced the likelihood of acquiring VR for education, tourism, and work. For VR ownership and variability, those who purchased VR during the pandemic were more likely to report buying it for work. Those with access to high-end VR hardware were more likely to report a broader range of uses, including socializing, health, and telemedicine. Validating the importance of various applications during the pandemic, we found that the desire for social interactivity mediates the impacts of COVID-19 on future adoption intentions. Theoretically, we propose several gratifications sought via the use of VR during the pandemic. Practically, we discuss recommendations for future VR research, marketing, and software design.

Keywords:

Virtual Reality, VR, Uses and Gratifications Theory, COVID-19, pandemic

Highlights:

- Uses and Gratifications Theory is applied and extended to examine the use and adoption of VR devices during the COVID-19 pandemic.
- Purchasing VR during the pandemic is related to use for work, education, and gaming.
- Games and entertainment are the most popular uses of VR during the COVID-19 pandemic.

- VR for telemedicine is the least popular use for VR during the COVID-19 pandemic.
- Social interactivity is a predictor of both the use and purchase intentions of VR devices.
- The relationship between the perceived impact of COVID-19 and purchase intention of VR devices is mediated by social interactivity and use intention of VR devices simultaneously.

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has impacted every aspect of our lives, including how we work, play, learn, exercise, and socialize. Virtual reality (VR) technology has the potential to mitigate many of the challenges brought about by the pandemic, which has spurred increased adoption (Shirer & Soohoo, 2020). While promising, consumer's long-term adoption of VR headsets into the future remains unknown (GlobalData, 2020). Most importantly, the VR adoption rate is still relatively low, and user experience seems to be one of the major barriers to VR adoption (Petrov, 2021). Therefore, this study seeks to understand better the relationship between VR adoption and user experience of VR from the perspective of the uses and gratifications within the unique context of the COVID-19 pandemic.

With the recent introduction of high-quality consumer-grade VR head mount displays (HMDs), individuals are attempting to leverage the affordances of VR to help during the pandemic. VR may be one of the most significant "industry 4.0" technologies that could help address the COVID-19 pandemic (Javaid et al., 2020) and appears to possess the unique affordances and modalities to address many of the pandemic's short- and long-term challenges (Imperator et al., 2020). Some industry watchers believe that the pandemic might be the "jump-start" that VR needs to establish itself in the mainstream (Osterland, 2020). For example, people design collaborative VR tools to facilitate working from home (Spatial Systems Inc, 2020; Wiederhold, 2020) and learning from virtual labs and classrooms (Dunnagan & Gallardo-Williams, 2020). Moreover, VR technologies can potentially help us improve our mental health by allowing us to connect with people and places during quarantine (AARP Innovation Labs, 2020; Riva & Wiederhold, 2020) and serve as a means to address physical health in at-risk populations such as older adults (Gao et al., 2020; Huang, 2020).

Medical professionals also utilize VR for research, telemedicine, and public outreach related to COVID-19 (Singh et al., 2020). For example, VR helps researchers visualize COVID-19 molecular structures (Calvelo et al., 2020). Likewise, VR has been used to educate medical professionals for years and could play an invaluable role in educating medical professionals about/during COVID-19 (Iyengar et al., 2020; Pears et al., 2020; Pérez-Escamirosa et al., 2020; Ruthenbeck & Reynolds, 2015). Leveraging VR could even assist in the palliative care of COVID-19 patients (Wang et al., 2020).

The above examples are in no way an exhaustive list of the use cases in which VR may be applicable and beneficial during and after the pandemic. Broadly speaking, the ability to virtually travel anywhere, meet with loved ones, learn together, and work with colleagues, and receive medical care has become even more salient as many become confined to their homes.

There are three main goals of this study. First, we seek to examine the myriad of uses of VR and their relation to hardware differences. Second, we explore how the perceived impacts of COVID-19 might influence the uses and gratifications of VR driving adoption during the pandemic and the significance of device ownership and variability. Third, we propose the potential importance of social interactivity within VR as a driving force behind VR adoption intentions. The Uses and Gratifications Theory (UGT) provides the theoretical framework for this study.

2. Theoretical Foundation

2.1. Uses and Gratifications Theory (UGT)

As one of the most prominent and prolific media theories, researchers have employed UGT to examine media effects and technology adoption for decades. Some scholars note that the development of UGT marks a shift in media effects research more broadly (Ruggiero, 2000).

UGT assumes that people make rational and active decisions regarding media selection and focuses on understanding why people select particular media over others (Rubin, 2009). This distinction is important because media cannot significantly impact people if they do not find a use for it and subsequently integrate it into their lives (Katz, 1959). In this study, we seek to understand the uses and gratifications of VR that drive people to adopt VR into their lives during the COVID-19 pandemic.

In the past, UGT has been used extensively to examine traditional media such as television and music (Lonsdale & North, 2011; Rubin, 1983). Later, an explosion of new media studies studied the various gratifications sought/obtained by the Internet and the multitude of uses therein (LaRose et al., 2001; Stafford et al., 2004). Currently, UGT is once again providing the theoretical foundation for examining emerging interactive technologies. For example, UGT has been used to explore the gratifications afforded by interactive media technologies such as video games, augmented reality, virtual worlds, and esports (Gallego et al., 2016; Lin & Chen, 2017; Sherry et al., 2006; Weiss, 2011). UGT has also been used effectively to examine individual applications/uses that drive emerging technology adoption, such as the AR game Pokémon Go (Bueno et al., 2020; Hamari et al., 2019; Vaterlaus et al., 2019). These studies demonstrate the importance of specific uses of emerging technology which can motivate people to adopt and use new technology.

Furthermore, UGT is well suited for studying VR effects/adoption because it is particularly relevant during the introduction of new communication mediums (Ruggiero, 2000). UGT is applicable in this case due to its inherent flexibility and ability to evolve with the latest media technologies (Rubin, 2009). In other words, as our communication technologies evolve, so too does UGT, which can quickly accommodate new uses and new gratifications within ever-

changing contexts. Ultimately, UGT can be applied to studying all kinds of media and across many different conditions, making it an ideal theory to ground the study of emerging technologies and unique situations (Taherdoost, 2018). Therefore, UGT provides a relevant framework to examine VR as an emerging technology and the potential importance of the COVID-19 pandemic as a contextual factor influencing usage and adoption.

2.2. Perceived Impacts of COVID-19 and VR Uses and Gratifications

UGT has been recently employed as a theoretical framework to examine technology usage motivations during the COVID-19 pandemic. Thus far, the bulk of the UGT work related to the pandemic has been centered around information dissemination/consumption on social media platforms, including sharing and consuming COVID-19 information (Haman, 2020; Islam et al., 2020) and disseminating fake news related to COVID-19 (Apuke & Omar, 2020, 2021). UGT has even shed light on students' perceptions of distance education during the pandemic (Durak & Çankaya, 2020). These studies indicate a need to evaluate the uses and gratifications of new media technologies during times of crisis, such as the COVID-19 pandemic.

The pandemic has impacted people in various aspects, including increasing financial worry, decreasing social support, and leading to health anxiety and loneliness (Tull et al., 2020). The perceived impacts of COVID-19 may serve as a contextual factor that potentially impacts how people use VR. Therefore, we seek to explore both the uses and gratifications of VR during the pandemic and how the COVID-19 pandemic might influence VR uses and gratifications.

Considerable research has been devoted to studying VR effects; however, there is much less examining the factors that drive VR adoption (Huang et al., In-Press; Kim et al., 2020; Lee et al., 2019). While research exploring the specific uses and gratifications of VR is still nascent, there are some notable examples of how UGT has been applied to the study of VR. In particular,

one study examined the uses and gratifications of journalism that harnesses VR (known as immersive journalism) (Nielsen & Sheets, 2019). Results from a series of focus groups indicated that immersive journalism fulfills six interconnection gratifications: control, empathy, emotion, immersion, information, and transportation. The culmination of these factors may allow consumers to experience news stories in more emotional ways, which differentiates VR journalism from traditional journalism.

Another study explored the uses and gratifications of the emerging market of VR tourism (Kim et al., 2020). An online panel survey indicated that VR tourism fulfills three important gratifications: informativeness, social interactivity, and playfulness. The three gratifications were found to have positive impacts on both authentic experience and subjective well-being. While this research is promising, this study attempts to address several potentially important gaps within the current U&G literature related to VR.

2.3. Gaps in the Literature: The Roles of Technology Acceptance in UGT

While the effects of VR have been widely studied, to date, there has been far less research devoted to the acceptance and adoption of VR (Huang et al., In-Press; Kim et al., 2020; Lee et al., 2019). Media effects scholarship is essential; however, emerging technologies such as VR cannot have significant effects if they are not adopted (Katz, 1959). Therefore, as UGT scholarship indicates, researchers need to examine the factors that influence the adoption of emerging technologies. Furthermore, the COVID-19 pandemic provides a unique opportunity to explore the adoption of VR. The popular press has indicated that VR HMDs such as the Oculus Quest have been largely sold out during the pandemic (Johnson, 2020). Therefore, the potential benefits of VR for those quarantined may have spurred increased VR adoption. We seek to build

on the still burgeoning VR adoption literature by further examining factors driving VR adoption during a potentially unique and important adoption event.

Previous VR adoption studies have examined specific VR content, such as VR tourism and VR journalism (Kim et al., 2020; Nielsen & Sheets, 2019). Studies examining specific uses and gratifications of VR content are invaluable, but there is currently a gap in the literature related to more varied uses of VR. Over time, the multitude of applications (or apps) for VR platforms have risen substantially. For example, beyond gaming, one can now find productivity apps, travel apps, physical fitness apps, mental health apps, social apps, etc., on the Oculus Quest storefront (Oculus, 2021a).

There is also a parallel need to examine the potential importance of hardware differences that may influence the kinds of content consumed in VR. Many of the apps mentioned above are platform/hardware-specific or have reduced functionality on lower-end devices like the Oculus Go (Oculus, 2021b). Therefore, an examination of hardware differences that could influence the uses and gratifications of VR, and ultimately adoption, is necessary. To address these gaps, we need to examine the relationship between device-related factors, user-related variables, and the perceived impacts of COVID-19.

2.4. VR Device-Related Factors, User Variables, and Perceived Impacts of COVID-19

As the preceding section states, previous studies focused on one specific use of VR (i.e., VR journalistic and VR tourism), and we further examine more diverse, and broader VR uses, which may fulfill various gratifications and drive adoption. Likewise, the above studies focused on VR content. They did not examine the importance of VR device-related factors (i.e., the variability of VR headsets), which may be a critical factor contributing to uses and gratifications (Kim et al., 2020). In the current study, we also seek to investigate the importance of device

ownership and variability related to various VR uses while also exploring how the pandemic may impact these variables.

Lastly, previous studies examining VR adoption have found that social interactivity may be a technological attribute of VR devices that could drive adoption into the future (Huang et al., In-Press; Kim et al., 2020; Lee et al., 2019). Specifically, we predict the degree to which VR users can interact with other users on a device will predict VR use and purchase intentions. Furthermore, based on Technology Acceptance Model (TAM) and previous research on VR adoption (e.g., Manis & Choi, 2019), social interactivity and VR use intention will subsequently mediate the relationship between the perceived impacts of COVID-19 and future VR purchase intentions.

2.5. Proposed Theoretical Framework, Research Questions, and Hypotheses

To sum up our literature review, we proposed a framework to examine relationships and interactions between three main factors: Perceived impacts of COVID-19, VR Device-related variables, and User-related variables (see Figure 1). Based on previous sections, we proposed four research questions and two hypotheses:

RQ1: What are the various uses and gratifications of VR use during the pandemic?

RQ2: How do the perceived impacts of the COVID-19 pandemic predict the potential uses and gratifications of VR?

RQ3: In what ways, if any, does VR device ownership and variability impact the potential uses and gratifications of VR?

RQ4: How has the COVID-19 pandemic impact VR ownership and variability?

H1: Social interactivity will positively predict (a) intention to use and (b) intention to purchase VR.

H2: Social interactivity and intention to use VR will influence (mediate) the relationship between the perceived impact of COVID-19 and intention to purchase VR.

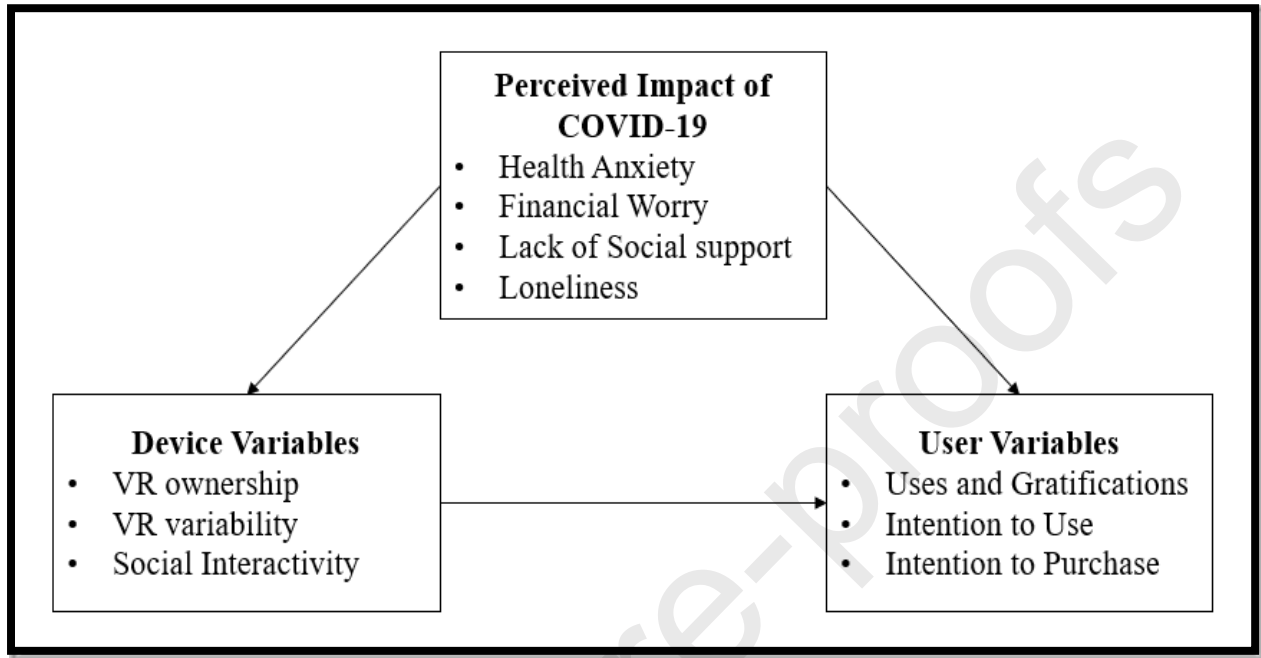


Figure 1. Proposed Theoretical Framework

3. Material and Methods

3.1 Participants and Procedures

Data collection was conducted through Amazon Mechanical Turk (MTurk). MTurk is an online crowdsourcing platform widely used for research purposes (Goodman et al., 2013).

Participants (otherwise known as “Turkers”) receive a small amount of monetary compensation after completing Human Intelligence Tasks (HITs) on the MTurk website (Paolacci & Chandler, 2014). Depending on the complexity of the task, Turkers earn anywhere from 1 cent to a couple dollars for each HIT completed (Ross et al., 2010). Compared to data collected from undergraduate research pools, the data collected via MTurk is considered equal or better quality (Miller et al., 2017).

The researchers posted a HIT onto the MTurk platform during the Fall of 2020. The HIT noted the nature of the task (i.e., survey) and the monetary compensation associated with the task (i.e., one dollar). The HIT was open to all “Turkers” that were located within the United States and logged onto the MTurk website during data collection. Therefore, the only excluding criterion was regional. The HIT remained available until the target sample was reached of approximately 310 responses. In total, the survey was active for roughly 72 hours (i.e., 3 consecutive days).

A total of 312 participants were recruited for this study. Fourteen participants did not complete the survey or had missing data on the predictors of interests and were therefore excluded from data analyses. After data cleaning, the usable sample was reduced to 298 participants. All participants received one dollar as compensation once they submitted their codes presented at the end of the survey to MTurk, regardless of HIT completion.

All procedures performed in the current study were approved beforehand by a university Institutional Review Board (IRB Approval #[blinded]). In compliance with ethical standards, informed consent was obtained from participants when they agreed to participate in this study. Furthermore, steps were taken to protect Turkers’ identity/privacy. Response data were not shared outside of the research team, identifying information (i.e., Turker ID numbers) were removed from the data after incentives were distributed, and results were only reported in aggregate.

3.2 Survey Instrument

This study uses a custom-created cross-sectional survey to investigate the impacts of COVID-19 on people's attitudes toward virtual reality hardware. The survey questionnaire is

composed of questions on (1) technology acceptance variables, (2) uses and gratifications of VR, (3) perceived impacts of COVID-19, (4) VR hardware-related measures, and (5) demographics.

We adopted the technology acceptance items related to VR adoption verbatim as developed by Manis and Choi (2019), which slightly modify the Davis (1989) traditional technology acceptance measures. The Manis and Choi (2019) VR acceptance items included separate scales for intention to use VR (Use Intention) and Intention to Purchase VR (Purchase Intention). Each of these scales is composed of four survey questions, and each question is equally weighted. The response options for each question range from 1 (strongly disagree) to 7 (strongly agree). Responses were averaged to attain an overall scale score, ranging from 1 (respondent marked each of the four items as 1) to 7 (respondent marked each of the four items as 7). We also included a 3-item scale of social interactivity developed by Lee et al. (2019). The reliability was acceptable for all of the above variables (Cronbach's $\alpha = 0.84, 0.88, \text{ and } 0.80$, respectively).

To measure participants' uses and gratifications of VR, we covered both traditional and new UGT dimensions sought by VR users, including Education, Tourism, Gaming, Movies, Socializing, Work, Mental Health, Physical Health, and Telemedicine. The measure of the perceived impacts of COVID-19 was developed based on a recent study on how the pandemic impacted people's psychological outcomes (Tull et al., 2020). Participants were asked to report how much they were affected by the pandemic in the following domains: financial worry, social support, health anxiety, and loneliness. The response categories ranged from 1 (no impact at all) to 5 (impacted my life a great deal). The items were averaged to attain an overall scale score, ranging from 1 (respondent marked each of the four items as 1) to 5 (respondent marked each of the four items as 5) (Cronbach's $\alpha = 0.79$).

We also include several VR hardware-related measures and demographic variables. Regarding VR hardware, we asked participants to report their device ownership (e.g., whether they owned a VR device and when they purchased their devices) and variability (e.g., types of VR devices they owned) in the questionnaire. Lastly, previous studies on VR hardware adoption (Huang et al., In-Press; Lee et al., 2019) found that multiple demographic variables, such as sex, age, income, education level, and race, were associated with the perception and acceptance of VR devices. Therefore, in the current study, we also asked participants about their demographic information to control for the potential effects of demographics on technology adoption. The order of the sections presented in the questionnaire were: technology acceptance variables, uses and gratifications questions, VR hardware-related variables, the perceived impacts of COVID-19, and demographic variables.

3.3. Analytic Tools

First, we reported the descriptive analysis of the variables of interest. Second, a series of T-Tests and ANOVA were conducted to answer the first three research questions. Third, we further employed multinomial logistic regressions to answer the fourth research question. Lastly, we performed a series of ordinary least squares (OLS) regression analysis and PROCESS moderation-mediation analysis to test our hypotheses. The PROCESS path-analysis macro is an application developed by Hayes (2018) for testing mediating and moderating relationships based on ordinary least squares regression that can be installed in SPSS, SAS, or R statistical packages.

4. Results

4.1 Descriptive Statistics

Among the 298 respondents, more than 60% of participants were male, 70% were white, the ages ranged between 16 and 63 years old, and the average age was 35.43 years old.

Regarding the household income, more than three-fourths of the participants were between \$20,000 and \$79,000. For the education level, only about 11% did not have some level of higher education. Our sample characteristics are in line with the demographics found in other recent studies examining MTurk demographics. Specifically, a previous study found that MTurk respondents tend to have an average age of around 37 years old. The participants are primarily white (75%), highly educated, with a typical income distribution (Moss et al., 2020). One difference is that our sample contains a slightly higher percentage of males while other studies report more females (Moss et al., 2020).

Among our sample, almost 70% of the respondents reported that they owned VR hardware, and most of them (60.9%) purchased their devices during the pandemic. A recent VR adoption study found that only 50% of respondents indicated owning a VR device (Manis & Choi, 2019). Therefore, our sample would appear to have more adopters. However, our study is unique in its granular measurement of VR adoption. In other words, most of our respondents reported owning low-cost/low-end VR hardware, such as Google Cardboard (33.9%) and Samsung Gear VR (48.3%). Only about 15% of participants owned high-end VR HMDs, such as the HTC Vive or the Valve Index. Unfortunately, due to a lack of data, we cannot determine if our sample's adoption rate is typical for the MTurk (or internet using) population at large. Table 1 shows the descriptive information of participants' demographic characteristics and VR ownership and variability.

TABLE 1 ABOUT HERE

For technology acceptance-related variables, participants reported an average of 5.41 points on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree) when they were asked about the importance of social interactivity of VR. Furthermore, participants also reported solid

intentions to use (5.38) and to purchase (5.41) (VR hardware on average. Table 2 presents the descriptive analysis of the technology acceptance variables.

TABLE 2 ABOUT HERE

Regarding the perceived impacts of COVID-19, the means were calculated based on the responses of the 298 participants. Respondents answered a series of COVID-19 related questions on a 5-point scale ranging from 1 (no impact at all) to 5 (impacted my life a great deal). Overall, participants reported a moderate amount of perceived impact (3.18). Participants also reported a moderate amount of the COVID-19 effects across all four individual categories. Health anxiety is the highest among all the perceived impacts (3.23), and financial worry is the next (3.19), followed by a lack of social support (3.16) and loneliness (3.14). Table 3 presents the descriptive analysis of the perceived impacts of COVID-19.

TABLE 3 ABOUT HERE

4.2. Reported VR Uses During the Pandemic (RQ1)

Our first research question (RQ1) explores the potential uses of VR during the pandemic. To answer this question, we included a descriptive analysis of the uses of gratifications of VR reported by our respondents during the pandemic. The leading use was gaming (64.4%), followed by movie-watching (53.7%) and work (46.0%). Approximately 40% of participants reported using VR for tourism (39.3%) and education (37.2%). Regarding other types of uses and gratifications, 24.2% of participants used VR for socializing, 24% used VR for mental health, and 18.8% used it for physical health. There were also 9.1% of participants who used VR for telemedicine. Table 4 shows the percentages of various types of VR uses.

TABLE 4 ABOUT HERE

4.3. Perceived Impacts of COVID-19 on VR Uses (RQ2)

A series of T-tests were performed to answer the second research question (RQ2). The goal was to investigate any differences in the types of VR uses between high and low COVID-19 impact groups. Therefore, we divided participants into two groups (below and above the average) based on their perceived impacts of the COVID-19. T-Tests were performed to investigate whether perceived impacts of the COVID-19 pandemic predict the uses of VR. The results suggested that health anxiety predicts people's use of VR for work purposes ($t(293) = 2.05, p = .041$). Meanwhile, a lack of social support predicts using VR for mental health ($t(293) = 2.45, p = .015$) and telemedicine-related purposes ($t(293) = 2.24, p = .026$). Lastly, loneliness predicted using VR for work purposes ($t(293) = 1.98, p = .049$). Financial worry was not a significant predictor of any type of VR use (See Tables 5-8).

TABLE 5-8 ABOUT HERE

4.4. Importance of VR hardware Ownership and Variability (RQ3)

The third research question (RQ3) examines whether VR device ownership and variability during the pandemic impacted the uses of VR. First, we compared those who purchased VR hardware during the pandemic to those who did not. The results indicated that those that purchased a VR HMD during the pandemic were more likely to report plans to use it for work ($t(293) = 2.29, p = .028$), education ($t(293) = 1.78, p = .083$), and games ($t(293) = 1.97, p = .056$) at a significant or marginally significant level (See Table 9). To examine the potential impacts of the device variability, we divided participants into four groups: no VR hardware, low-end (google cardboard), mid-range (Oculus Go, Samsung Gear), and high-end VR (oculus rift, quest, PSVR, HTC Vive). ANOVA results suggest that high-end users are more likely to report a desire to use VR for games ($F(3,294)=7.36, p<.001$), movies ($F(3,294)=3.31, p=.021$), socializing ($F(3,294)=6.54, p<.001$), work ($F(3,294)=4.89, p=.002$), mental health

($F(3,294)=4.39$, $p=.005$), physical health ($F(3,294)=2.84$, $p=.038$), and telemedicine ($F(3,294)=7.86$, $p<.001$) compared to other users (See Table 10).

TABLES 9 & 10 ABOUT HERE

4.5. Perceived Impacts of COVID-19 on VR Ownership and Variability (RQ4)

The fourth research question (RQ4) focuses on how the COVID-19 pandemic impacts VR ownership and variability. For VR ownership, people who reported more health-related anxiety associated with the pandemic were almost two times (1.99) more likely to purchased VR hardware during the pandemic than those who already owned one. Other aspects of the perceived impact of the pandemic did not predict VR ownership. Regarding VR variability, the results suggest that people impacted by the COVID-19 pandemic in terms of social support are 2.06 times more likely to purchase high-end VR than low-end VR. Other aspects of COVID-19 impacts did not predict VR variability. The results of logistic regression analyses are presented in Tables 11 & 12.

TABLES 11 & 12 ABOUT HERE

4.6. The Importance of Social Interactivity (H1 & H2)

We conducted a mediation test to address our hypothesis (H1), which proposes a positive relationship between social interactivity and (a) use intention and (b) purchase intention of VR hardware during the pandemic. The results suggest that social interactivity is a predictor of both intention to use ($b = .76$, $t(296) = 19.91$, $p < .001$) and intention to purchase VR ($b = .73$, $t(296) = 18.49$, $p < .001$) at a significant level. Therefore, H1 was supported.

To test the proposed mediation relationship (H2), we used PROCESS macro to conduct a mediation test (model 6). The results suggest two indirect effects despite of no direct effect. First, participants' perceived COVID-19 impacts indirectly predicted people's intention to use and

purchase VR hardware via social interactivity (95% CI [.06, .21]). Second, the perceived impacts of COVID-19 predicted people's perceived social interactivity of VR, which later predicted their VR use intention and then VR purchase Intention (95% CI [.09, .22]). Therefore, H2 was also supported. Figure 2 presents the direct and indirect effects of COVID-19 impacts on VR purchase intention.

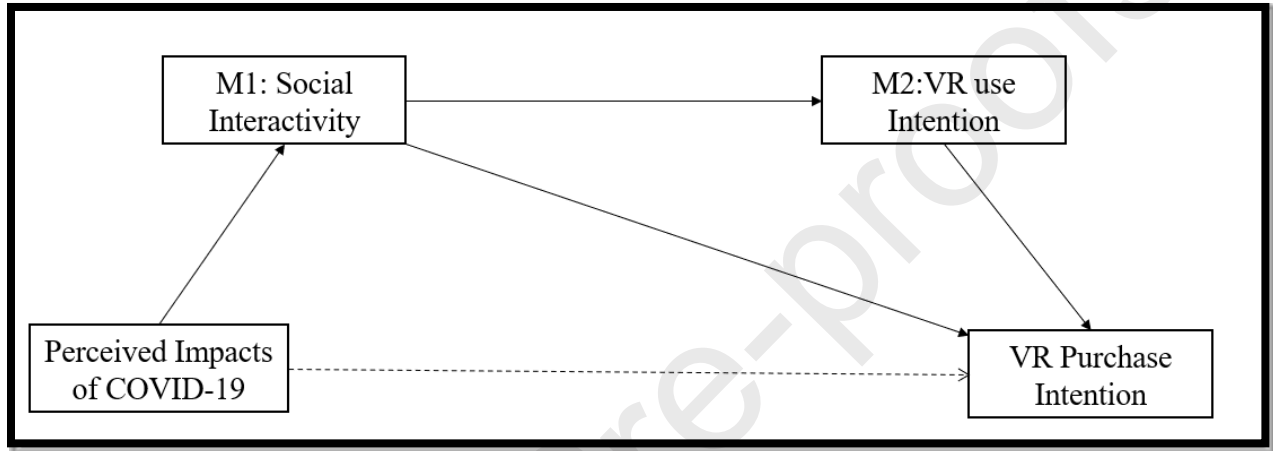


Figure 2: Double Sequential Mediation Model

5. Discussion

5.1. Summary of The Findings

We proposed four research questions and two hypotheses in this study. The first research question explores the various uses and gratifications of VR use during the pandemic.

Unsurprisingly, among the nine VR uses we listed, playing games and watching movies were the most popular uses of VR. Conversely, using VR for telemedicine was the least popular activity.

Our second research question explored how respondents' perceived impacts of the pandemic might predict their VR uses. The findings showed that health anxiety and loneliness associated with the pandemic led to using VR more for work. Meanwhile, a lack of social support during the pandemic led to more mental health and telemedicine uses of VR.

The third research question aimed to answer whether VR device ownership and variability impacted reported VR use. The findings suggest that those that purchased VR during the pandemic were more likely to use it for work, education, and gaming. Furthermore, those that reported owning a high-end VR headset were more likely to use VR for games, movies, socializing, work, mental health, physical health, and telemedicine. In other words, those with higher-end hardware were more likely to use VR for everything except tourism and education.

The fourth research question investigated how the pandemic impacted VR ownership and variability. Our results indicated that participants who reported higher health anxiety about the pandemic were almost twice as likely to purchase VR hardware during the pandemic. Other pandemic-related factors were not associated with an increased likelihood of purchasing VR hardware. However, those who reported less social support during the pandemic were more than twice as likely to buy high-end VR hardware during the pandemic.

We also made two predictions related to the importance of social interactivity. Our first hypothesis posited that social interactivity would predict respondents' intention to adopt (i.e., use and purchase) VR hardware during the pandemic. Our results supported this hypothesis as social interactivity appeared to be a strong predictor of both intentions to use VR and an intention to purchase VR. Therefore, it would appear that social interactivity can promote VR adoption.

Finally, our second hypothesis predicted that social interactivity and use intentions would mediate the relationship between COVID-19 impacts and VR purchase intentions. We found that the pandemic's perceived impacts did not directly impact people's intention to purchase VR hardware. Instead, perceived COVID-19 effects indirectly influenced respondents' purchase intentions via their desire for social interactivity while using VR and the intention to use VR. In

other words, social interactivity appears to be a crucial factor when examining VR device adoption during the pandemic.

5.2. Theoretical Contributions

This study makes several theoretical contributions to the UGT and VR literature. UGT is a highly adaptable theoretical framework that can be employed to understand better the uses of emerging technologies across diverse contexts (Rubin, 2009; Ruggiero, 2000). Scholars also started to examine the uses and gratifications of VR for various purposes, such as tourism and journalism (Kim et al., 2020; Nielsen & Sheets, 2019). To our knowledge, this is the first study to examine VR uses more broadly by including nine potentially important uses of VR. Therefore, the first contribution of this study is to extend this UGT VR research by examining a more broad and diverse set of uses and gratifications of VR hardware.

Second, several recent studies examine the uses and gratifications of multiple media within the unique context of the pandemic. For example, scholars have examined information sharing and consumption on social media during the pandemic (Apuke & Omar, 2020, 2021; Haman, 2020; Islam et al., 2020). To our knowledge, there is still limited research on VR uses and gratifications within the context of the COVID-19 pandemic. Our research adds empirical evidence to demonstrate how the perceived impacts of the pandemic might influence the uses of VR during the pandemic.

The third contribution of this study is related to the importance of device-related variables when examining the uses and gratifications of VR. Specifically, our results indicate that VR needs to be examined with an understanding that there is currently a great deal of device variability in the VR market. In previous studies, device variability is primarily examined in the context of cost, with higher quality headsets costing substantially more money which

subsequently impacts adoption (Manis & Choi, 2019). While cost is an essential factor, device variability is also significant as our results indicate that diverse VR hardware leads to different uses of VR. Furthermore, previous UGT VR studies focus on content rather than hardware (Kim et al., 2020; Nielsen & Sheets, 2019). This study attempts to examine both the importance of content and hardware to gain a more nuanced understanding of VR use during the pandemic. Therefore, future studies should consider the importance of device-related variables when examining the potential uses of VR.

Fourth, there is a robust and ever-growing body of research examining the media effects of VR. However, there is a much smaller body of research examining the adoption and uses of VR (Huang et al., In-Press; Lee et al., 2019; Manis & Choi, 2019). Building upon previous VR UGT studies, we proposed a more holistic theoretical framework to examine the interplay between contextual factors, device-related variables, and user-related variables through the lens of UGT. Relatedly, a vital component of UGT is to identify the needs that are being gratified by media use. Therefore, this study expands upon the needs/gratifications that have been identified in previous studies and examines how device-related factors impact respondents' needs and gratifications in the context of the pandemic.

5.3. Practical Implications

The results of our study also have practical implications for the VR industry more broadly and for VR designers more specifically. First, our findings empirically support popular press articles that indicated that the pandemic could be "jump-starting" VR adoption (Osterland, 2020). Specifically, the majority of our respondents (70%) reported owning a VR headset, which is a higher adoption rate than other similar VR studies (50%) (Manis & Choi, 2019). Furthermore, most of our respondents purchased their headsets since the start of the pandemic (~61%), which

is another finding that empirically supports popular press articles indicating a recent surge in VR adoption (Johnson, 2020). Therefore, for VR designers, the pandemic may function as an opportunity to increase user's intention to use and purchase VR hardware.

Second, the effects of the pandemic on people's lives seem to be influencing interest in VR technology as a means of fulfilling several needs. Specifically, respondents that reported health worries during the pandemic were almost twice as likely to purchase a VR headset. Likewise, those that reported a need for social support were more than twice as likely to buy a high-end VR headset. In other words, the pandemic may influence the number of VR devices people will purchase and the types of VR devices they will buy. Ultimately, it would appear that people seek out VR to gratify several essential needs during the pandemic, which could allow the industry to expand its range of uses and its audience.

Third, our findings demonstrate that people are receptive, and maybe even eager, for diverse uses of VR. While typical activities such as gaming and watching movies were the most reported uses, other much less marketed uses, such as using VR for work, were still significant. These findings indicate that people are using VR to fulfill a diverse range of gratifications. Therefore, designers should build increased functionality across a more comprehensive array of use case scenarios to improve adoption. Relatedly, the myriad uses of VR will also need to be marketed effectively to expose more people to the potential of VR to satiate more varied uses and gratifications (Huang et al., In-Press). In support of this recommendation, a cursory analysis of the 30 most popular games (i.e., most played) currently listed on the Oculus Quest online storefront reveals an array of social apps, productivity apps, and fitness apps in addition to more traditional game experiences (Oculus, 2021a).

Lastly, our findings also support other studies that found social interactivity to be an essential factor driving VR adoption (Kim et al., 2020). In fact, the prospect of interacting with others via the medium of VR was found to be one of the most critical factors influencing adoption in this study. Therefore, VR designers should carefully consider the integration of social features into their VR experiences. Once again, examining the top 30 most popular Oculus Quest games would appear to support this finding. Specifically, social VR experiences like *Rec Room* and *VRChat* are among the top five most popular titles on the Oculus Quest online storefront (Oculus, 2021a). Therefore, designers should build more social experiences and consider adding social interactivity elements to already released experiences to fulfill users' social needs.

5.4. Limitations and Future Research

We must acknowledge several limitations which should be considered when interpreting the above findings. We hope that these limitations can be addressed in future scholarship surrounding VR adoption and use. First, we attempted to create a list of VR uses representing the most common and current uses of VR. We also tried to include some emerging uses of VR. However, we must acknowledge that this list is not exhaustive, and there are potentially important uses that may not be represented in this study. Furthermore, like any new media, the uses of VR may change over time, and new uses may emerge. Therefore, future studies may wish to consider exploring potential uses that were not included in this study.

Second, we chose to use MTurk for data collection. Studies indicate the validity of using MTurk to access hard-to-reach populations (Smith et al., 2015). Previous research also demonstrates that MTurk data is as reliable as other common convenience samples (i.e., college student samples) (Fleischer et al., 2015). However, we must recognize potential drawbacks to

using MTurk (Huff & Tingley, 2015). While these issues are not limited to MTurk samples, future studies may wish to replicate our study using other sampling techniques.

Relatedly, we employed a cross-sectional survey design for this study and our sample was drawn from respondents with internet access and located within the United States. Therefore, we must acknowledge that there are potential limitations related to the generalizability of our findings. We suggest that future studies consider employing qualitative methods and exploring the link between the pandemic and VR uses with more nuance. Furthermore, future researchers may also want to employ a longitudinal design with a more diverse sample to examine evolving uses after the pandemic.

6. Conclusion

This study extends previous research on UGT by applying the theoretical framework to explore both user-related factors and device-related variables during the COVID-19 pandemic. In doing so, we examine these theories in an unprecedented setting wherein individuals' perspectives related to media use, social interaction, and concerns for health and safety have undergone an abrupt and major paradigm shift. Therefore, this study provides a glimpse into some of the social needs, priorities, and behaviors regarding VR use during a global crisis. As such, these findings may be particularly useful and provide some foundation to researchers exploring UGT and media use in the wake of other crises, natural disasters, or times of global disruption.

Moreover, users have sought out VR at an increased rate during the pandemic, thereby leading to an industry "boom." Our study indicates that users are adopting VR during the pandemic for a myriad of reasons. This finding supports the notion that VR is indeed capable of addressing many of the challenges posed by the pandemic. An increased understanding of what

people need from VR, how people are using VR, and how they wish to use VR in the future could help push the adoption of this technology well past the pandemic.

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Table 1. The descriptive information of demographic characteristics and VR variables (N=298)

Variable	Categories	Number of Participants (%)
Sex	Male	190 (63.5%)
	Female	108 (36.1%)
Age	16-63 (Means=35.43, SD=9.74)	
Household Income	Less than \$10,000	13 (4.4%)
	\$10,000-\$19,999	11 (3.7%)
	\$20,000-\$29,999	32 (10.7%)
	\$30,000-\$39,999	30 (10.1%)
	\$40,000-\$49,999	32 (10.7%)
	\$50,000-\$59,999	63 (21.1%)
	\$60,000-\$69,999	32 (10.7%)
	\$70,000-\$79,999	40 (13.4%)
	\$80,000-\$89,999	15 (5.0%)
	\$90,000-\$99,999	10 (3.6%)
	\$100,000-\$149,999	15 (5.0%)
	More than \$150,000	7 (1.7%)
Education Level	High school graduate	8 (2.7%)
	Some college	18 (6.0%)
	2-year degree	6 (2.0%)
	4-year degree	180 (60.4%)
	Master's degree	79 (26.5%)
	Doctorate	5 (1.7%)
Race/Ethnicity	White	209 (70.7%)
	Black/African American	60 (20.1%)
	American Indian or Alaska Native	8 (2.7%)
	Hispanic/Latino	12 (4.0%)
	Asian	7 (2.3%)
	Others	2 (0.6%)
VR Hardware Ownership	No	90 (30.4%)
	Yes, but not purchasing one after March 2020	28 (9.4%)
	Yes, and purchasing one after March 2020	179 (60.2%)
Types of VR Hardware (check all that apply)	Google Cardboard	101 (33.9%)
	Samsung Gear VR	144 (48.3%)
	Oculus Go	32 (10.7%)
	Oculus Rift(s)	40 (13.4%)
	Oculus Quest	47 (15.8%)
	HTC Vive	42 (14.1%)
	PlayStation VR	66 (22.1%)
	Valve Index	22 (7.4%)

Table 2. Descriptive Analysis of TAM variables

Construct (Numbers of Items; Cronbach's α)	Mean (Standard Deviation)
Social Interactivity (3 items; 0.80) Example Item: If I could share content with others on virtual reality devices, I would use them more	5.41 (1.09)
Intention to Use (4 items; 0.84) Example Item: I will use VR hardware within the foreseeable future.	5.38 (1.05)
Intention to Purchase (4 items; 0.88) Example Item: I intend to purchase VR hardware within the foreseeable future.	5.41 (1.15)

Note: Response categories are ranging from 1 (strongly disagree) to 7 (strongly agree)

Table 3. Descriptive Analysis of Perceived Impacts of COVID-19

Construct (Cronbach's α)	Mean (Standard Deviation)
Perceived Impacts of COVID-19 (0.79)	3.18 (0.82)
Health Anxiety	3.23 (1.03)
Financial Worry	3.19 (1.06)
Lack of Social Support	3.16 (1.01)
Loneliness	3.14 (1.12)

Note: Response categories are: 1 (None), 2 (A little), 3 (A moderate amount), 4 (A lot), and 5 (A great deal)

Table 4. Descriptive Analysis of VR Uses & Gratifications

VR Uses & Gratifications	% (N)
Education	37.2 (111)
Tour	39.3 (117)
Game	64.4 (192)
Movie	53.7 (160)
Socializing	24.2 (72)
Work	40.6(137)
Mental Health	24.8 (74)
Physical Health	18.8 (56)
Telemedicine	9.1(27)

Table 5. T-Test (Health Anxiety)

Health Anxiety			
	Low	High	t-test (df=293) (p-value)
Education	39.1%	31.5%	1.166 (.244)
Tour	39.1%	39.7%	.093 (.926)
Game	65.3%	61.6%	.571 (.569)
Movie	53.3%	54.8%	.217 (.828)
Socializing	24.4%	23.3%	.200 (.842)
Work	49.3%	35.6%	2.051(.041)*
Mental Health	24.0%	27.4%	.582 (.561)
Physical Health	19.1%	17.8%	.247 (.805)
Telemedicine	9.3%	8.2%	.287 (.774)

Note: N=298. *P<.05

Table 6. T-Test (Financial Worry)

Financial Worry			
	Low	High	t-test (df=293) (p-value)
Education	37.4%	35.7%	.276 (.782)
Tour	39.8%	38.1%	.271 (.786)
Game	63.5%	67.9%	.704 (.482)
Movie	55.8%	47.6%	1.290 (.198)
Socializing	23.2%	26.9%	.537 (.592)
Work	45.5%	47.6%	.392(.743)
Mental Health	25.1%	23.8%	.234 (.815)
Physical Health	18.0%	21.4%	.674 (.501)
Telemedicine	10.0%	7.1%	.753 (.452)

Table 7. T-Test (Lack of Social Support)

Lack of Social Support			
	Low	High	t-test (df=293) (p-value)
Education	39.2%	32.0%	1.121 (.263)
Tour	41.6%	33.3%	1.256 (.502)
Game	67.6%	57.3%	1.607 (.109)
Movie	55.5%	48.4%	1.137 (.256)
Socializing	23.5%	26.3%	.896 (.371)
Work	50.0%	37.9%	.921(.358)
Mental Health	26.5%	21.1%	2.445 (.015)*
Physical Health	19.0%	19.0%	.777 (.438)
Telemedicine	11.0%	4.0%	2.238 (.026)*

Note: N=298. *P<.05

Table 8. T-Test (Loneliness)

Loneliness			
	Low	High	t-test (df=293) (p-value)
Education	37.0%	37.9%	.148 (.822)
Tour	38.0%	42.1%	.668 (.502)
Game	65.0%	65.3%	.044 (.965)
Movie	55.5%	48.4%	1.137 (.256)
Socializing	23.5%	26.3%	.525 (.600)
Work	50.0%	37.9%	1.980 (.049)*
Mental Health	26.5%	21.1%	1.011 (.313)
Physical Health	19.0%	19.0%	.011 (.991)
Telemedicine	9.0%	9.5%	.130 (.897)

Note: N=298. *P<.05

Table 9. T-Test (Purchased VR vs. not purchased VR last year)

Purchased VR Last Year			
	No (28)	Yes (179)	t-test (df=293) (p-value)
Education	21.4%	36.9%	1.778 (.083)+
Tour	25.0%	39.7%	1.490 (.138)
Game	78.6%	61.5%	1.968 (.056) +
Movie	53.6%	51.4%	.211 (.834)
Socializing	17.9%	25.6%	.776(.439)
Work	28.6%	9%	2.293 (.028)*
Mental Health	21.5%	25.1%	.422(.674)
Physical Health	14.3%	20.1%	.723 (.470)
Telemedicine	10.7%	10.1%	.107 (.915)

Note: N=298. +P<.1, *P<.05

Table 10. ANOVA analysis

Dependent Variable	No	Low	Medium	High	F (3,294)	η²
Education	.422 (.49)	.333 (.49)	.422 (.49)	.422 (.49)	1.921	.019
Tour	.433 (.50)	.278 (.46)	.316 (.47)	.430 (.50)	1.389	.014
Game	.656 (.48)	.167 (.38)	.632 (.49)	.719 (.45)	7.361***	.070
Movie	.578 (.50)	.222 (.43)	.487 (.50)	.588 (.49)	3.306	.033
Socializing	.256 (.44)	.056 (.24)	.105 (.31)	.351 (.48)	6.537*	.063
Work	.433 (.50)	.333 (.49)	.329 (.47)	.588 (.49)	4.890**	.048
Mental Health	.256 (.44)	.111 (.32)	.132 (.34)	.342 (.48)	4.385**	.043
Physical Health	.178 (.38)	.111 (.32)	.105 (.31)	.263 (.44)	2.838*	.028
Telemedicine	.067 (.25)	.000 (.00)	.000 (.00)	.182 (.38)	7.855***	.074

Note: N=298. *P<.05, **P<.01, ***P<.001

Table 11. Logistic Regression (Reference group: Owning VR, but not purchasing VR last year)

		B	S.E.	Wald	Sig	OR	95% CI	OR
Not Owning VR hardware	Health Anxiety	.310	.299	1.077	.299	1.364	.759	2.449
	Financial Worry	.110	.264	.173	.678	1.116	.666	1.870
	Lack of Social Support	-.505	.287	3.088	.079+	.603	.344	1.060
	Loneliness	.041	.241	.029	.865	1.042	.649	1.673
	Female	.044	.467	.009	.925	1.045	.418	2.610
	Age	.025	.024	1.032	.310	1.025	.977	1.075
	Household Income	.077	.097	.636	.425	1.080	.894	1.305
	Educational Level	.151	.227	.439	.507	1.163	.744	1.816
		B	S.E.	Wald	Sig	OR	95% CI	OR
Purchased VR hardware last year	Health Anxiety	.688	.288	5.707	.017*	1.990	1.132	3.500
	Financial Worry	.101	.255	.157	.692	1.106	.671	1.824
	Lack of Social Support	-.330	.274	1.451	.228	.719	.420	1.230
	Loneliness	.190	.229	.687	.407	1.209	.772	1.893
	Female	-.625	.453	1.906	.167	.535	.220	1.300
	Age	.014	.024	.336	.562	1.014	.968	1.062
	Household Income	.133	.093	2.055	.152	1.142	.952	1.371
	Educational Level	.402	.225	3.192	.074+	1.495	.962	2.324

Note: N=298. +P<.1, *P<.05

Table 12. Logistic Regression (Reference group: owning low-end VR)

		B	S.E.	Wald	Sig	OR	95% CI OR
Not Owning VR hardware	Health Anxiety	-.502	.338	2.209	.137	.605	.312 1.174
	Financial Worry	.179	.326	.302	.583	1.196	.631 2.266
	Lack of Social Support	.419	.350	1.435	.231	1.521	.766 3.021
	Loneliness	-.144	.302	.228	.633	.866	.479 1.565
	Female	1.966	.802	6.004	.014*	7.140	1.482 34.402
	Age	.004	.029	.021	.886	1.004	.949 1.063
	Household Income	-.006	.112	.003	.955	.994	.799 1.237
	Educational Level	-.942	.413	5.196	.023*	.390	.173 .876
		B	S.E.	Wald	Sig	OR	95% CI OR
Owning Medium- Grade VR	Health Anxiety	-.154	.338	.206	.650	.858	.442 1.663
	Financial Worry	-.002	.327	.000	.996	.998	.526 1.894
	Lack of Social Support	.566	.352	2.589	.108	1.761	.884 3.508
	Loneliness	.075	.303	.061	.805	1.078	.595 1.952
	Female	1.215	.811	2.244	.134	3.371	.687 16.530
	Age	-.021	.030	.475	.491	.980	.924 1.039
	Household Income	-.011	.112	.009	.924	.989	.795 1.232
	Educational Level	-.911	.415	4.828	.028*	.402	.178 .906
		B	S.E.	Wald	Sig	OR	95% CI OR
High- End VR	Health Anxiety	-.363	.329	1.215	.270	.696	.365 1.326
	Financial Worry	.284	.318	.796	.372	1.328	.712 2.479
	Lack of Social Support	.724	.343	4.464	.035*	2.062	1.054 4.036
	Loneliness	-.054	.294	.034	.855	.948	.532 1.686
	Female	1.639	.795	4.253	.039*	5.149	1.085 24.442
	Age	.000	.029	.000	.994	1.000	.946 1.058
	Household Income	.063	.109	.339	.561	1.065	.861 1.318
	Educational Level	-.733	.410	3.200	.074+	.480	.215 1.073

Note: N=298. +P<.1, *P<.05

Highlights:

- Uses and Gratifications Theory is applied and extended to examine the use and adoption of VR devices during the COVID-19 pandemic.
- Purchasing VR during the pandemic is related to use for work, education, and gaming.
- Games and entertainment are the most popular uses of VR during the COVID-19 pandemic.
- VR for telemedicine is the least popular use for VR during the COVID-19 pandemic.
- Social interactivity is a predictor of both the use and purchase intentions of VR devices.
- The relationship between the perceived impact of COVID-19 and purchase intention of VR devices is mediated by social interactivity and use intention of VR devices simultaneously.